

SURVIVAL RATE OF WILD ADULT PRAIRIE FALCONS DEDUCED FROM BAND RECOVERY DATA

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Introduction

The Prairie Falcon (*Falco mexicanus*) has been banded in the western United States and Canada at least since 1928. There are 184 recoveries of Prairie Falcons listed in the Bird Banding Laboratory's computer printout dated 23 October 1973. It is possible to estimate from these recoveries the survival rate of breeding-age Prairie Falcons in the wild, using the same methods used to extract a similar estimate for Peregrines (*Falco peregrinus*) from a sample of similar size (Shor 1970). Although the two species are similar in proportion and appearance, and to some extent in habit, the Prairie Falcon has a somewhat shorter life expectancy as an adult than the Peregrine if values deduced from band recovery data are to be believed.

Assumptions and Methods Used

The methods used in this paper have been described in some detail elsewhere (Shor 1970), but they will be repeated here in abbreviated form. The study is based on a number of assumptions. First, the number of recoveries is assumed to be proportional to the number remaining alive of a given cohort of adult birds. It is not possible to extend this assumption to include immature birds, because for most species their death rate is known to be considerably higher than that of adults. Recovery data indicate that the higher rate exists among immature Prairie Falcons as well. However, the assumption is probably roughly correct for adults, with which this study deals. A second assumption is that the recovery rate is higher during the first few months after banding than might be attributable to normal mortality rates. The higher rate is assumed to result from the fact that some of the raptors trapped and banded are caught because they are sick, weak, or injured and are therefore recovered at a higher rate than is representative of the population as a whole. Accordingly, no recoveries made less than a year after banding are considered. A third assumption is that most Prairie Falcons do not breed until their third year; so birds banded as nestlings or in their hatching year are not included in the sample until at least two years have passed. These precautions assure that only birds of breeding age are considered. Fourthly, in order to avoid another kind of bias, recoveries made by banders themselves are in most cases eliminated from the sample. Most Prairie Falcon recoveries by banders appear to have been made at or near a nest site, and it is not certain that banders working in an area will continue to do so over long periods. Therefore, such recoveries could tend to bias the results in the direction of a shorter-than-actual life span. Recoveries by banders not working at nest sites appear to be of the order of random captures and are therefore included if they can be so identified. Finally, the maximum life span of a Prairie Falcon is much longer than this sample indicates is normally achieved in the wild; the birds must very rarely die of old age. Therefore the mortality rate of adults is assumed to be constant, not changing with age.

All recoveries of birds banded in the nest or during their hatching year which are made at least two but less than three years after banding are included in the "base year" of the analysis. Similarly, all recoveries of birds banded after their hatching year which are made at least one but less than two years after banding are also included in the "base year." Later recoveries are included in the first, second, and later years after the base year, as appropriate. Once the totals in the base year and each succeeding year are determined, the life expectancy is found by fitting an exponentially decreasing function to the numbers recovered in the base year and each year thereafter through a maximum likelihood method. This function is corrected for the fact that the period of observation is of finite length and that long-lived birds can therefore be recovered only from the cohorts banded early in the interval.

The Data Base

There are 184 recoveries included in the data, of which 103 are of birds banded in 1955 and later. Banding data are available only on birds banded in 1955 and later, whereas recovery records are available back to birds banded in 1928. Corresponding to the 103 recoveries of birds banded from 1955 through 1972 are a total of 2717 birds banded. A few recoveries in 1973 are included, but they are all of birds banded in 1972 and earlier. Therefore dividing the 103 recoveries by the 2717 birds banded provides a rough approximation of the recovery rate—about 3.8 percent. A few more birds will be recovered from this group (551 were banded in 1972 alone), so that ultimately the recovery rate will go somewhat above 4 percent. A rough extrapolation indicates that it will reach about 4.3 percent if earlier recovery rates continue.

The band recovery rate for most other raptors was higher in the 1930s and 1940s than it is today, so that it can be expected that the recovery rate between 1928 and 1954 must have been higher than the one computed above for the interval 1955-73. Hence it can be expected that the number of birds banded to produce 81 recorded recoveries in the earlier interval was smaller than would have been required to produce 103 recoveries in the later period. Assuming a recovery rate of 4.3 percent, we get $81/.043 = 1884$ birds banded to produce 81 recoveries. There must actually have been fewer, so the total number of birds banded to produce the 184 recoveries discussed in this paper must have been less than $2717 + 1884 = 4601$.

Results

If the recoveries are sorted into those of birds banded as nestlings or hatching-year immatures and those banded later (listed as adults in Tables 1 and 2), a different pattern appears for the two classes. Here the first year after banding is the period from the day of banding to the day before the first anniversary of the banding; the second year is that starting the first anniversary of the banding; and so forth. There are few if any immatures in the recovery list that were banded after the end of the hatching year, so inclusion of such recoveries in the "adult" category does not bias the results significantly.

More than half the recoveries (56 percent) are of immature birds in their first year of life. A great proportion of them are recoveries by shooting. In fact 99 out of 129 recoveries of birds banded as nestlings are within a year of the time of banding. However, it does not follow that this number represents a death rate in the first year proportional to the recovery rate (i.e., $99/129$ or 77 percent). A conclusion of the study of Peregrine Falcon survival rates

(Shor 1970) was that immature Peregrines were much more likely to be recovered, in proportion to their death rate, than were adults. The same thing is likely to be true of immature Prairie Falcons. Hence the first-year death rate of birds banded in the nest may be considerably less than 77 percent. This possibility requires separate investigation.

Table 1
Prairie Falcon Recoveries by Others than Banders at Nest Sites,
Sorted by Age When Banded

Year after Banding	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Banded as Nestlings or Immatures	99	13	6	4	3	1	2	0	0	0	0	0	0	1	0
Banded as Adults	11	4	1	2	0	0	0	0	0	0	0	0	0	0	0
Banded at Unknown Age	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Table 2
Prairie Falcon Recoveries by Banders (Returns plus Foreign Retraps)
Sorted by Age When Banded

Year after Banding	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Banded as Nestlings or Immatures	5	3	2	1	1	0	0	0	0	0	0	0	0	0	0
Banded as Adults	2	3	3	1	1	0	0	0	0	0	0	0	0	0	0
Banded at Unknown Age	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

When we take all the data and rearrange them as in the study of Peregrine Falcons (conservatively treating the birds banded at unknown age as immatures and so eliminating their recoveries in the first two years after banding), we obtain the information shown in table 3. Data on Peregrine Falcons (Shor 1970) is added for comparison.

Table 3
 Prairie Falcon and Peregrine Recoveries of Breeding-Age Adults
 in Base Year and After

Year of Encounter, Related to Base Year	Base Year	1	2	3	4	5	6	7	8	9	10	11	12	13
Prairie Falcons Encountered (total)	16	9	7	2	3	0	0	0	0	0	0	1	0	0
Prairie Falcons Encountered (omitting returns and foreign retraps)	11	5	5	1	3	0	0	0	0	0	0	1	0	0
Peregrines Recovered	10	8	7	6	3	5	1	0	0	0	1	1	0	0

It can be concluded from an inspection of table 3 that the life expectancy of an adult Prairie Falcon in the wild is probably less than that of an adult Peregrine. However, this conclusion must be confirmed by comparison of calculated values for life expectancy including allowance for the finite length of the observation interval, since many of the Prairie Falcons banded were nestlings banded toward the end of the period covered by the data. In addition, to make the results comparable with those for Peregrines, the assumption is made that serious loss of bands does not start until the beginning of the fourteenth year after banding ($x=11$) and is complete by the start of the eighteenth year after banding.

Table 4
 Values of the Parameter c_x

x	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
c_x	1	.91	.85	.77	.74	.71	.69	.67	.65	.63	.60	.50	.35	.21	.07	0

Table 4 gives the correction parameter c_x which accounts for both the finite length of the period during which recoveries are possible and for the fact that bands will probably be lost. The correction is incorporated in the equation which we assume for the recovery rate for breeding-age Prairie Falcons:

$$L_x = c_x L_0 e^{-rx} \quad , \quad \dots (1)$$

where L_x is the number of birds recovered in the year starting x years after the beginning of the base year, L_0 is the number recovered in the base year, and r is the reciprocal of the life

expectancy, taken to be a constant for adults of all ages. This last assumption is justified by the fact that essentially none of the birds live long enough to die of old age, and so the causes of mortality affect all breeding-age birds in the sample in about the same way.

When a curve of the form of equation (1) is fitted to the recoveries of the second row of table 2 (recoveries of Prairie Falcons omitting returns and foreign retraps) by using a maximum likelihood method, the best fit is achieved with $L_0 = 10.2$ and $r = 0.422$. The reciprocal of 0.422 is a point estimate of the life expectancy of an adult Prairie Falcon in the wild—about 2.4 years—considerably less than the four-year life expectancy computed in the same manner for the breeding-age Peregrine (Shor 1970). It confirms the impression obtained by comparison of the recovery data for the two species in table 3.

It is difficult computationally to obtain an estimate of the statistical confidence of this point estimate directly from the maximum likelihood computation. However, a feel for the value can be obtained by finding the effect of statistical fluctuations in the number of birds recovered each year on the value of r computed by making a least squares fit to the data. Through this approximate scheme, 95 percent confidence limits of about 2.0 and 2.8 are derived for the life expectancy of a Prairie Falcon. Both these values are much less than the four years derived for the Peregrine, so it can reasonably be concluded that the life expectancy of an adult Prairie Falcon in the wild is considerably less than that of the Peregrine.

Acknowledgment

The author is indebted to Mr. Richard Fyfe of the Canadian Wildlife Service for permission to use in this statistical analysis the data on recoveries of Prairie Falcons that he has banded. Fyfe has banded more Prairie Falcons in recent years than any other bander.

Reference Cited

- Shor, W. 1970. Peregrine Falcon population dynamics deduced from band recovery data. *Raptor Res. News* 4(2):49-59.

PRELIMINARY NOTICE — 1976 MEETING OF THE RAPTOR RESEARCH FOUNDATION

As approved by the Board of Directors at the annual meeting in Boise last November, the 1976 meetings will be held at Ithaca, New York, home of Cornell University, with Dr. Tom Cade serving as local chairman. Cosponsoring organizations include the Laboratory of Ornithology and the Peregrine Fund. The meetings will commence on Friday, October 29, and run through Monday, November 1. The Ramada Inn in Ithaca will serve as conference headquarters, with some activities planned for the Laboratory of Ornithology at Sapsucker Woods. A call for papers and other details will be forthcoming in future announcements.